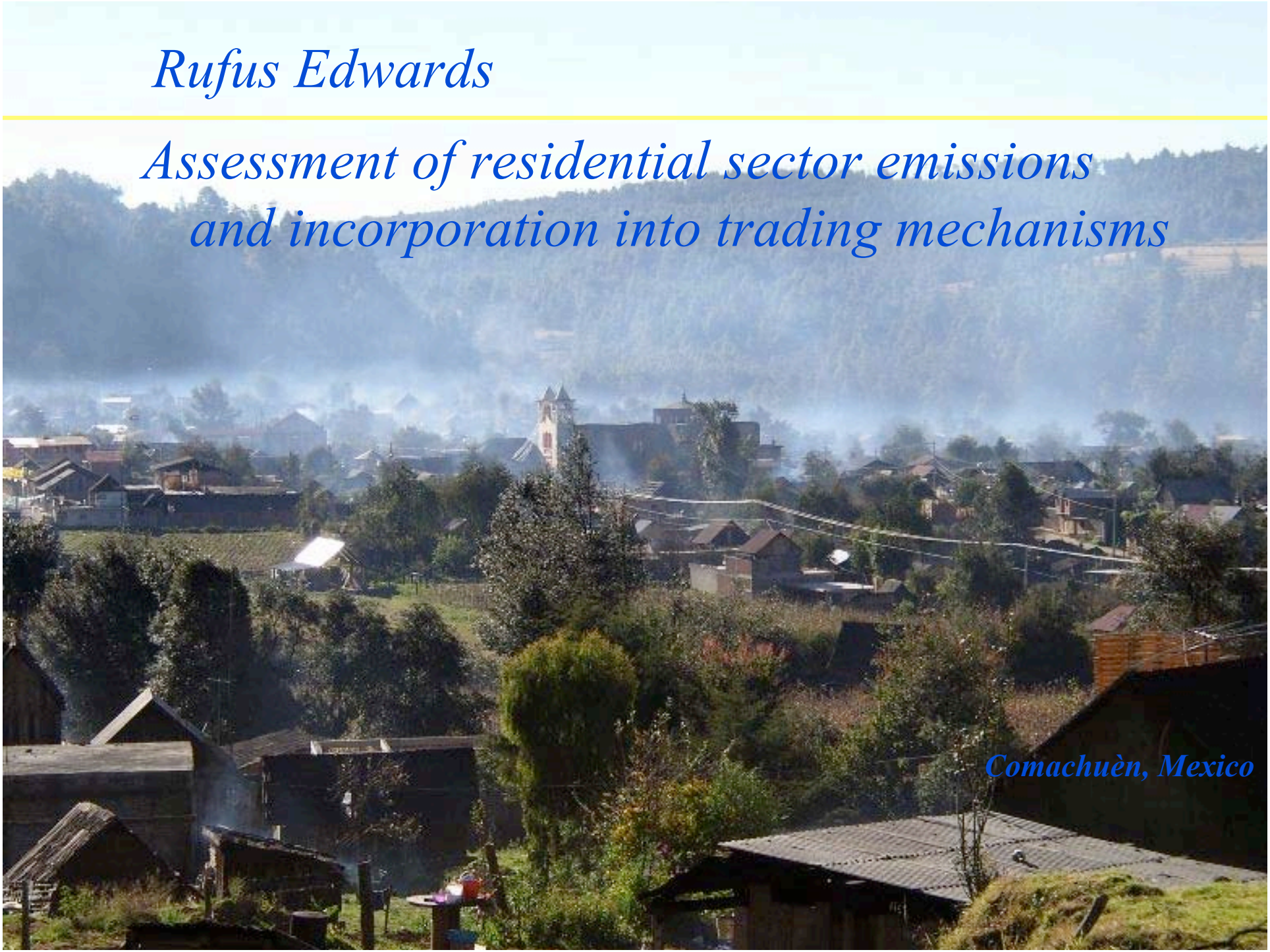
Rufus Edwards

Assessment of residential sector emissions and incorporation into trading mechanisms



Comachuèn, Mexico

Topics

- Plumes of pollution from rural areas and seasonal variation of fuel use
- Current emission factors and estimating global warming commitment from stove use
- Improvement of estimates, and methods for incorporation of this sector into trading mechanisms

Why would plumes of pollution downwind of rural areas vary seasonally in both concentration and composition?

- Highly diverse fuel usage patterns in rural regions in China.
- In approx 250 homes in the IAP database:
  - In Winter, 28 different fuel combinations used in the kitchens
  - In Summer, 34 different fuel combinations in the kitchens.

- Summer monitoring - average of 2.6 types of fuels were used per household. Decreased in winter, with 1.9 types per household, as numbers burning biomass and LPG fell, and numbers using coal rose.
- Multiple fuels used in the majority of the houses in the database during both the winter and the summer.
- In houses that were measured in both seasons in Shaanxi there was a shift in the fuel usage patterns between seasons.


Household use of mixed fuels

Seasonal changes of main cooking fuel

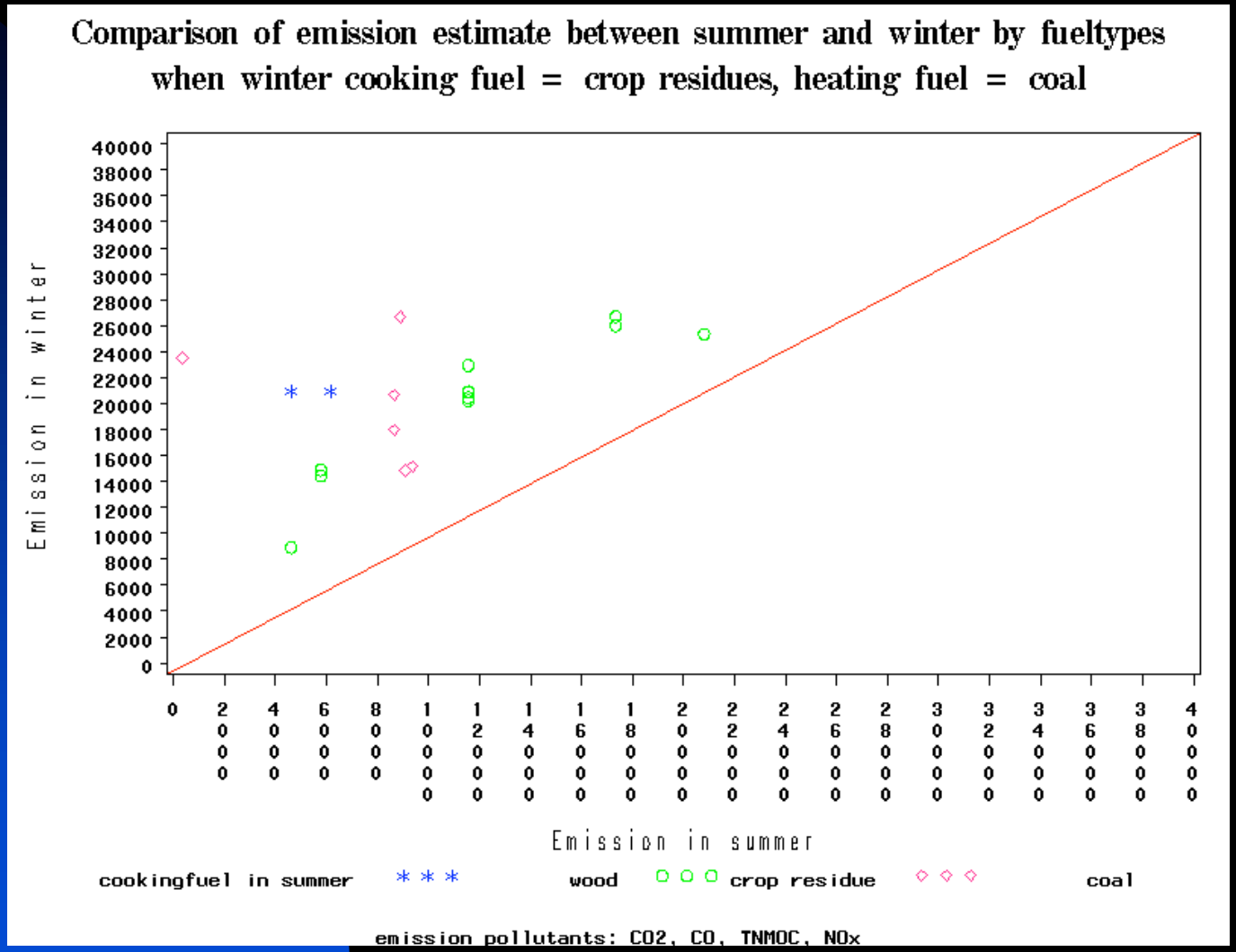
Seasonal change in cooking fuel for houses with heating in winter					
	Cooking fuel in winter				
Cooking fuel in summer	wood	crop residue	coal	LPG	Total
wood	1	3	5	0	9
crop residue	0	11	25	0	36
coal	0	6	6	1	13
Total	1	20	36	1	58

Although our overall sample of homes was much larger this is restricted to those we visited and monitored in both seasons

Seasonal changes of main cooking fuel with no heating

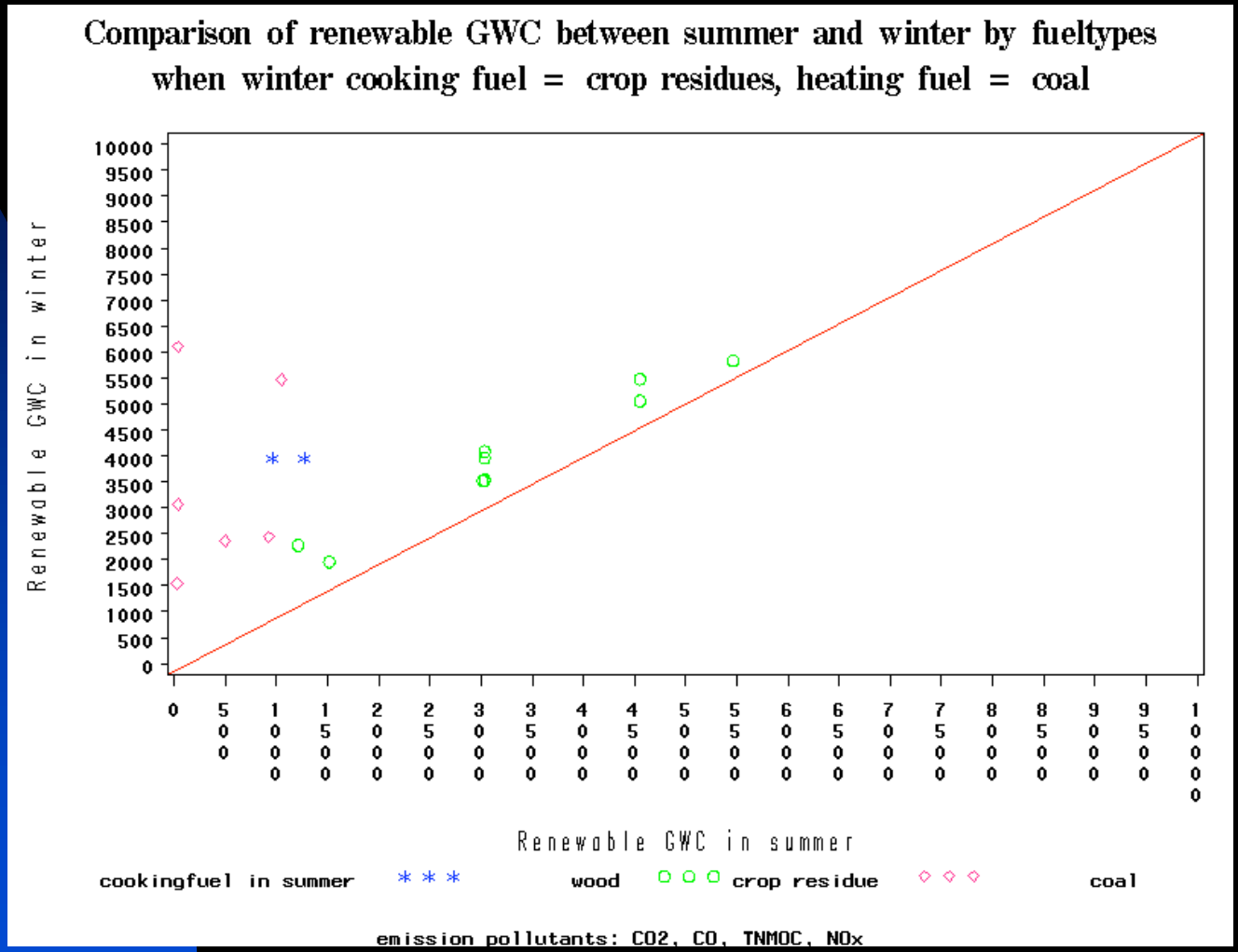
Seasonal change in cooking fuel for houses with no heating in winter					
Cooking fuel in summer	Cooking fuel in winter				Total
	wood	crop residue	coal	LPG	
wood	7	**1**	**1**	0	9
crop residue	**1**	2	**2**	0	5
coal	**3**	**2**	11	**2**	18
LPG	0	**1**	**2**	0	3
Total	11	6	16	2	35

Emissions estimates

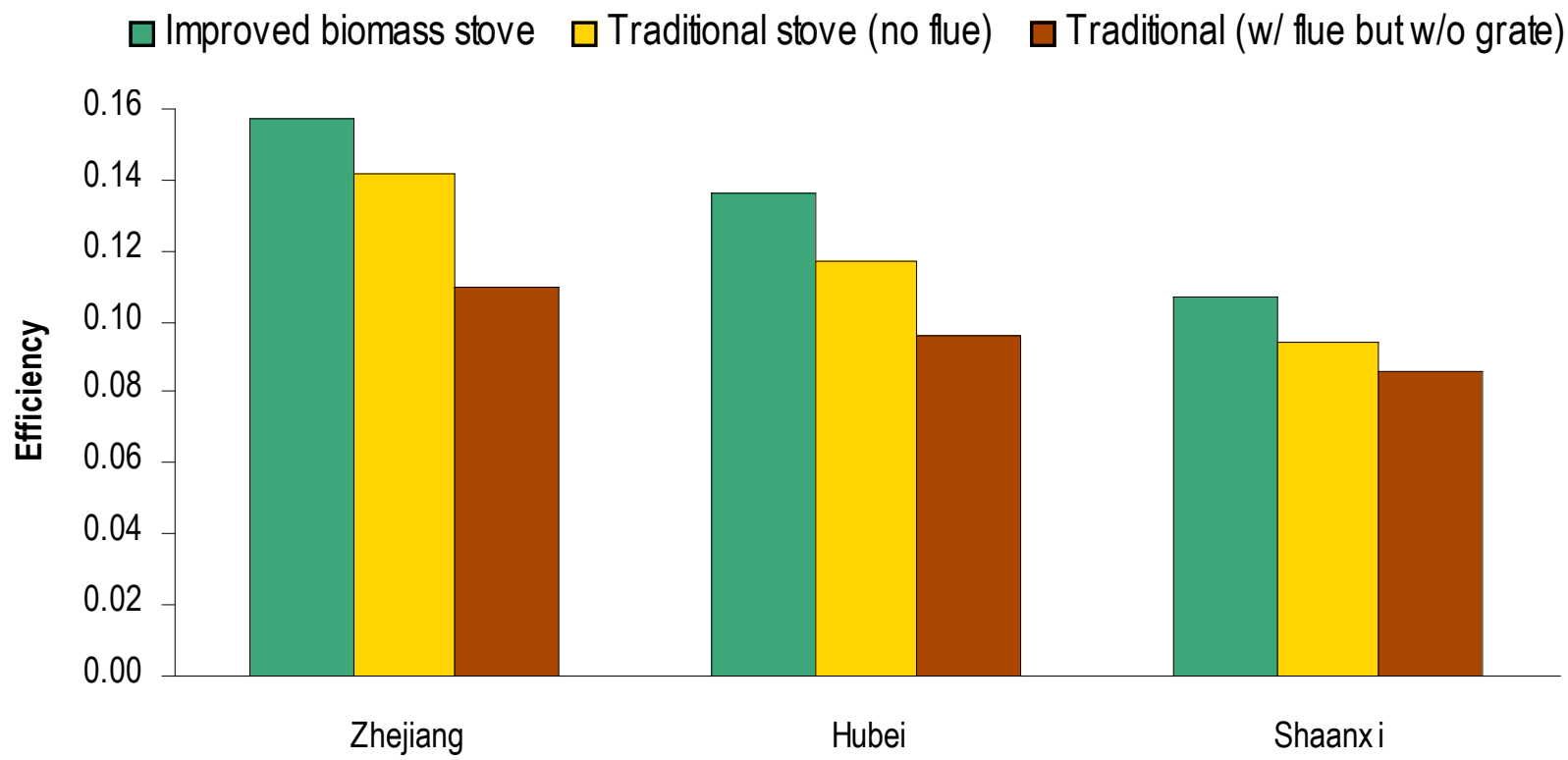


GWC gC

And when these are renewable?



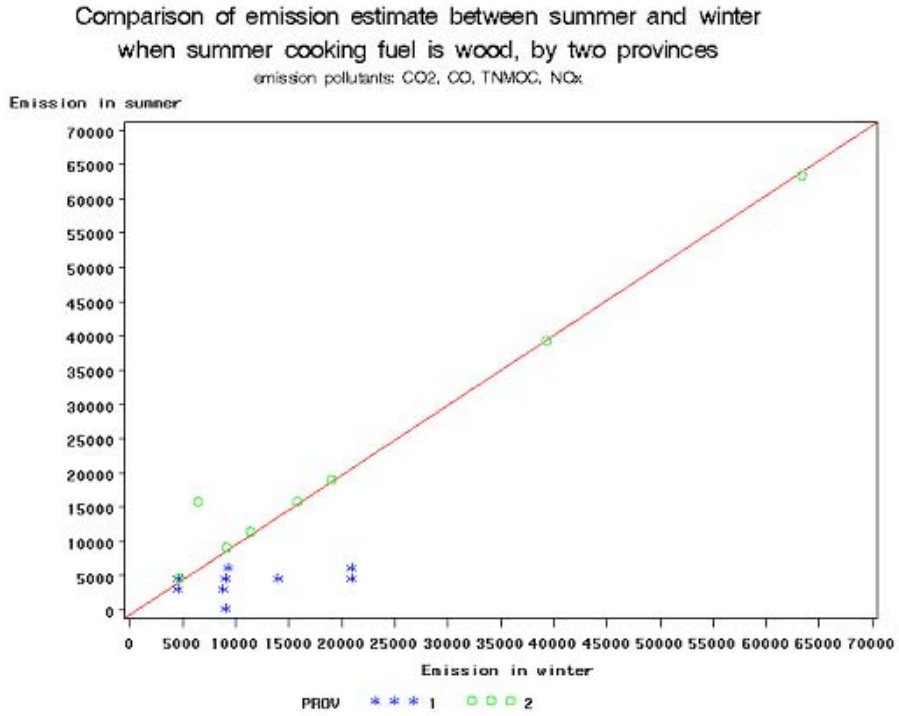
Efficiencies of stoves vary across region and across type—implying variations also in emissions characteristics.



Multiple stoves

Not only that, residential heating in different provinces also impacts our emissions assessment in rural houses

- many cooking stoves are also heating stoves in the winter, and emissions factors per MJ delivered will be smaller if the stove is preheated.
- even if using the same stove and efficiencies the fuel use and fuel change issues are considerable



Other GHG estimation issues using current emission factors - fuel type classification for which we have no emission factors

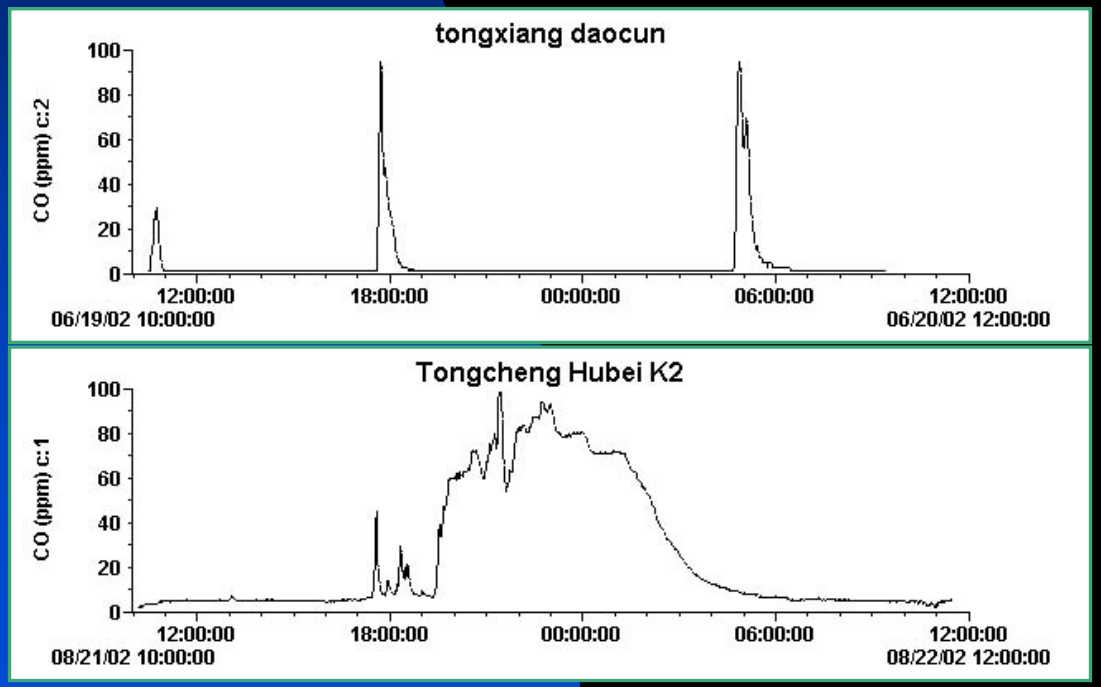
- do not cover all fuel/stove combinations in use by the 1.3 billion people in China.
- many other variations: local cooking practices, variations in construction techniques, differences in fuel quality, wind speed, dampening patterns, and indoor/outdoor temperature differences.

Current emission factors

- have required complex analytical instrumentation for multiple pollutants and analyses
  - Expensive
  - Require easier assessment of emissions without requirements for laboratory back up
- have been in simulated kitchens in the laboratory
  - in field emissions in rural kitchens are required

Current emission factors

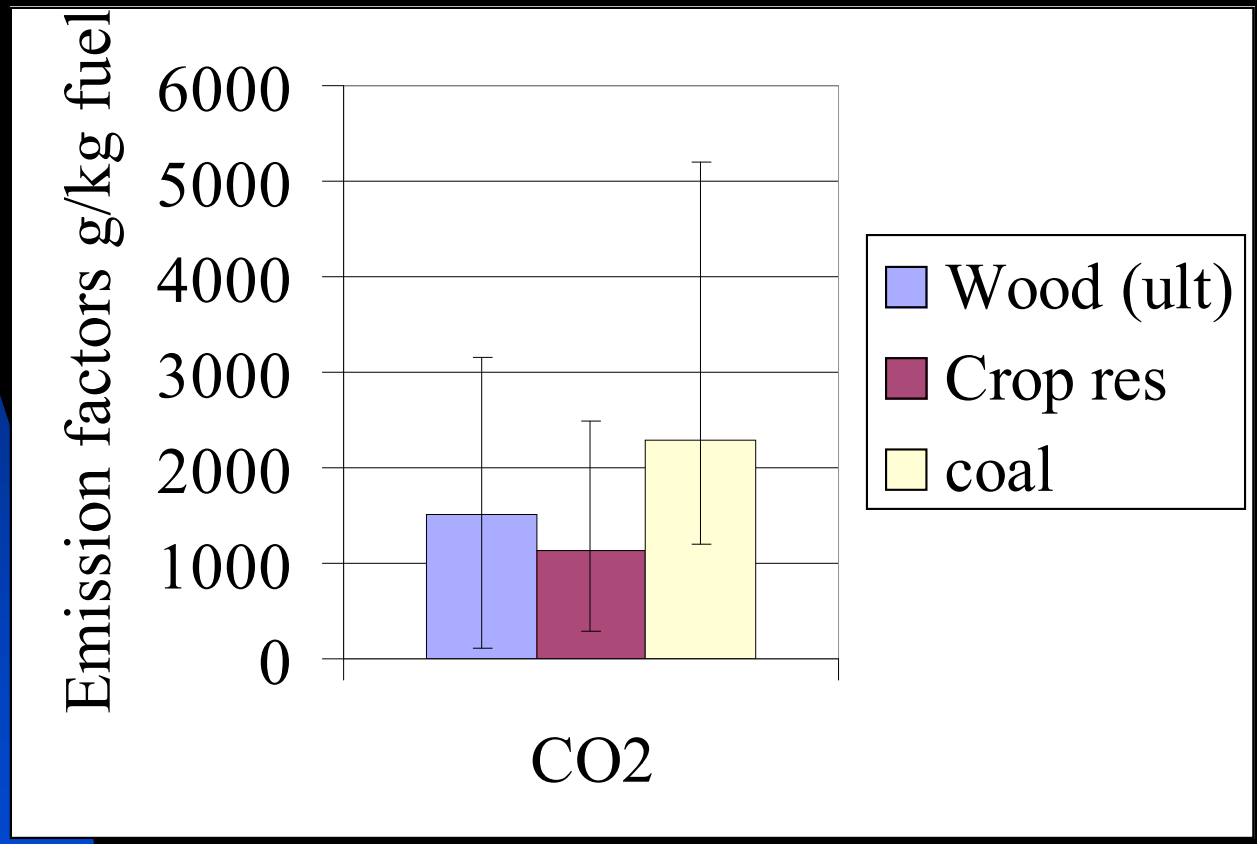
- are integrated over a test period, usually a water boiling test that lasts for 30-40 minutes
  - do not represent the range of activities that occur in a rural kitchen
  - more representative samples of emissions from houses during their daily cooking activities are required



- do not provide information on which parts of the cooking and combustion cycle the emissions are made, and what design approaches can be used to reduce them.

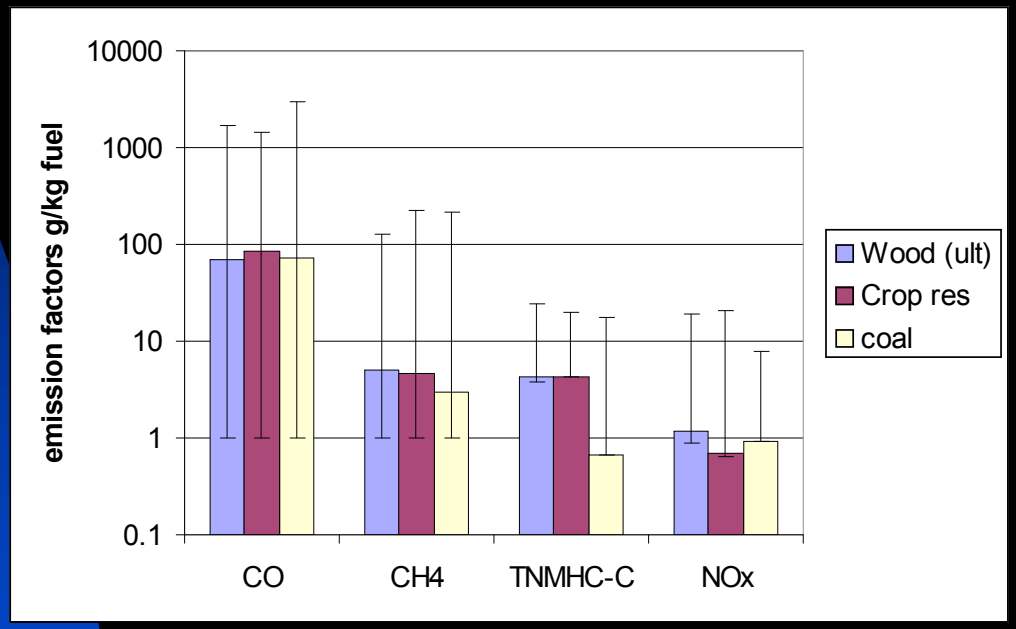
- Seasonal changes in fuel use and behavior are not captured

Variability in emissions estimates- CO2

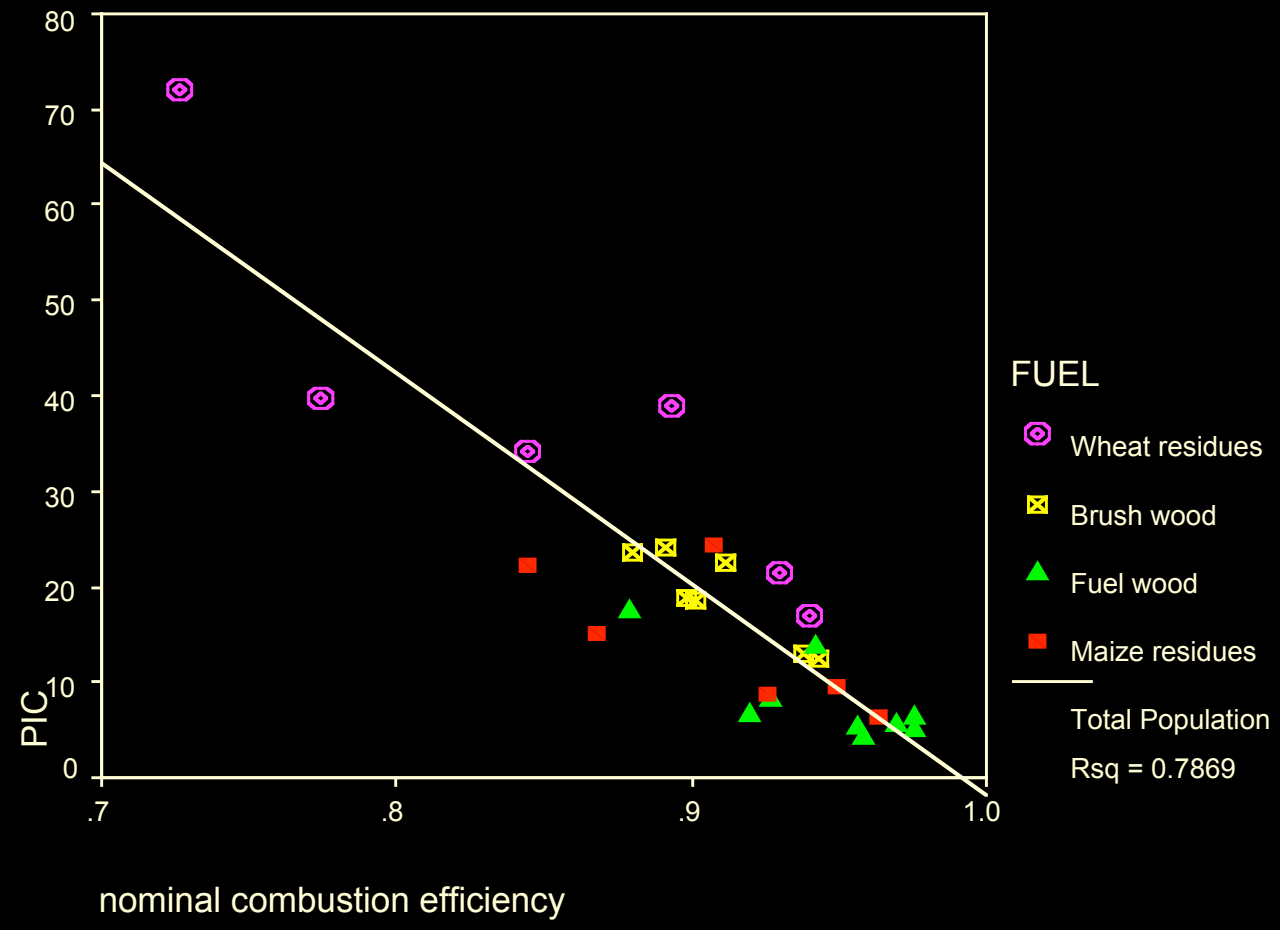


Variability in emissions estimates – CO, CH4, TNMHC, NOx

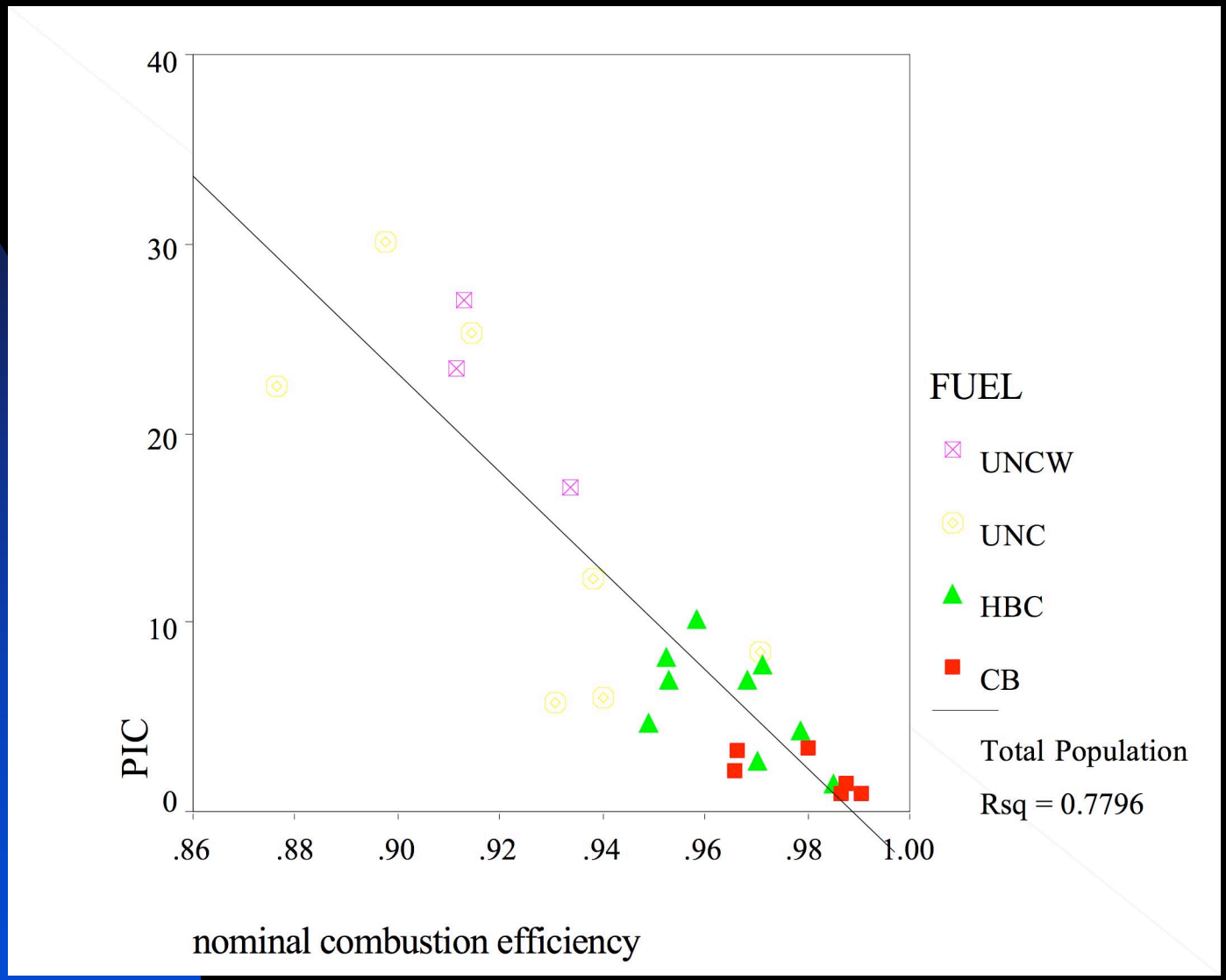
Log scale



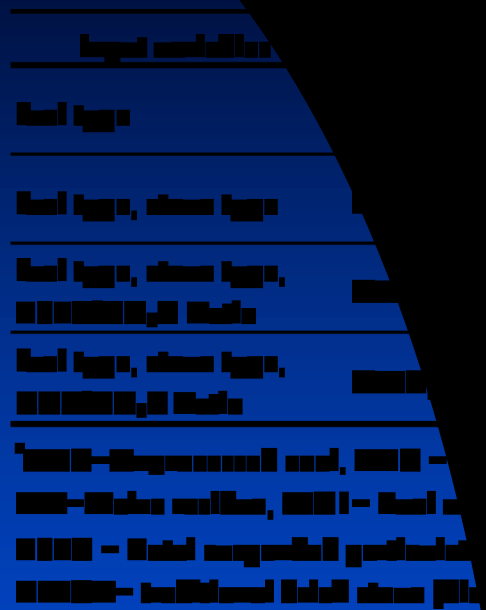
Are there simple ways of improving estimates?



PIC vs NCE of coal



Summary of regression models to predict GWC



- the CO/CO_2 ratio is a good surrogate for combustion efficiency. Thus as the models are intrinsically linked to the stove efficiencies some of the variability due to local cooking practices, variations in construction techniques, differences in fuel quality, etc. are indirectly accounted for in the dataset.

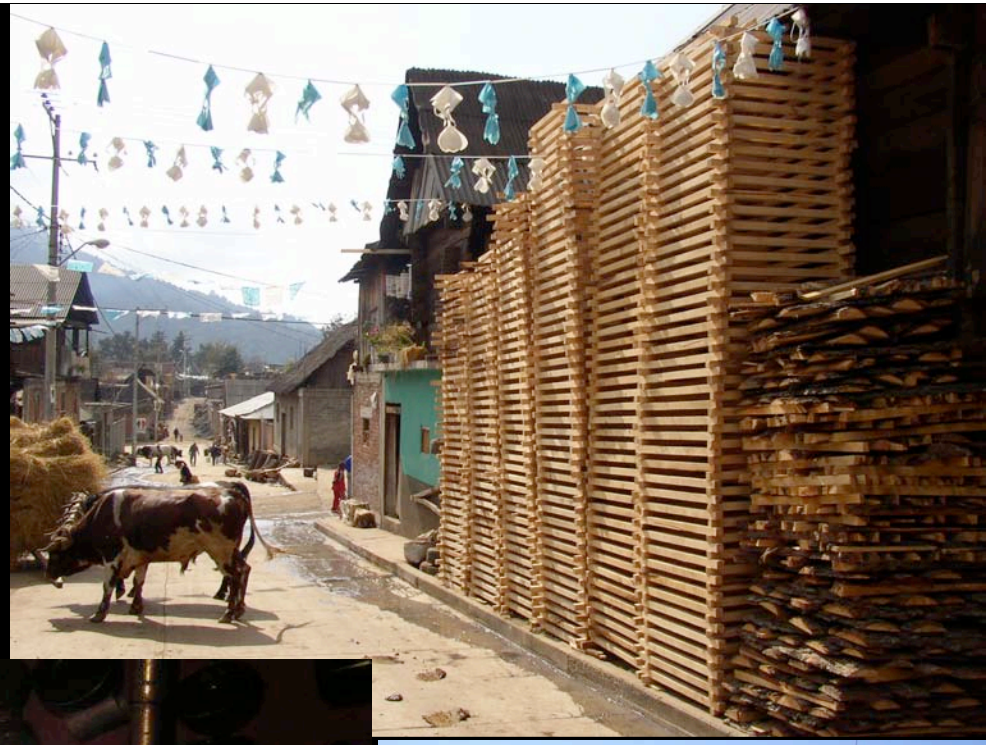
GHG measurement in the residential sector - advances in Mexico

- with simple economical continuous methods deployment over longer periods can be used to assess emissions indicate where emissions reductions could be made
- Larger surveys of emissions in the field would tend to incorporate some seasonal/stove variability

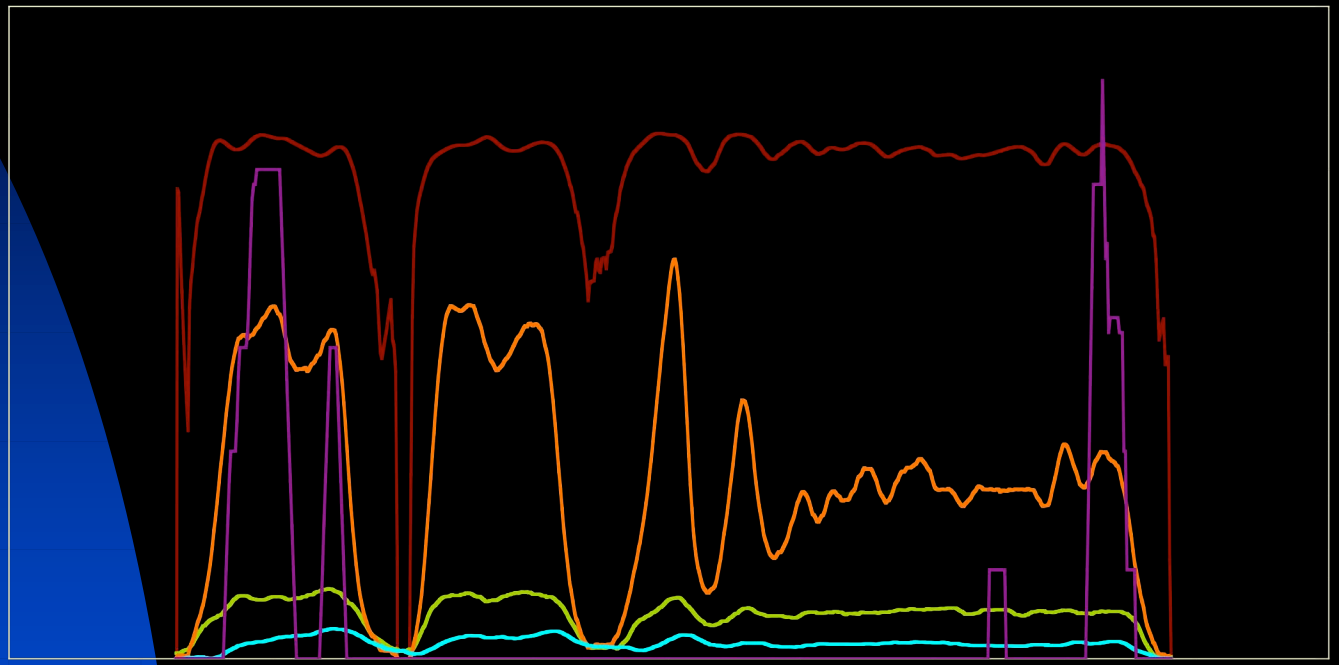
University of California Irvine

Comachuèn

- Population ≈ 4,000
- Elevation ≈ 7,500 ft
- No running water
- Little electricity
- Wood is primary fuel source



What do the profiles look like?



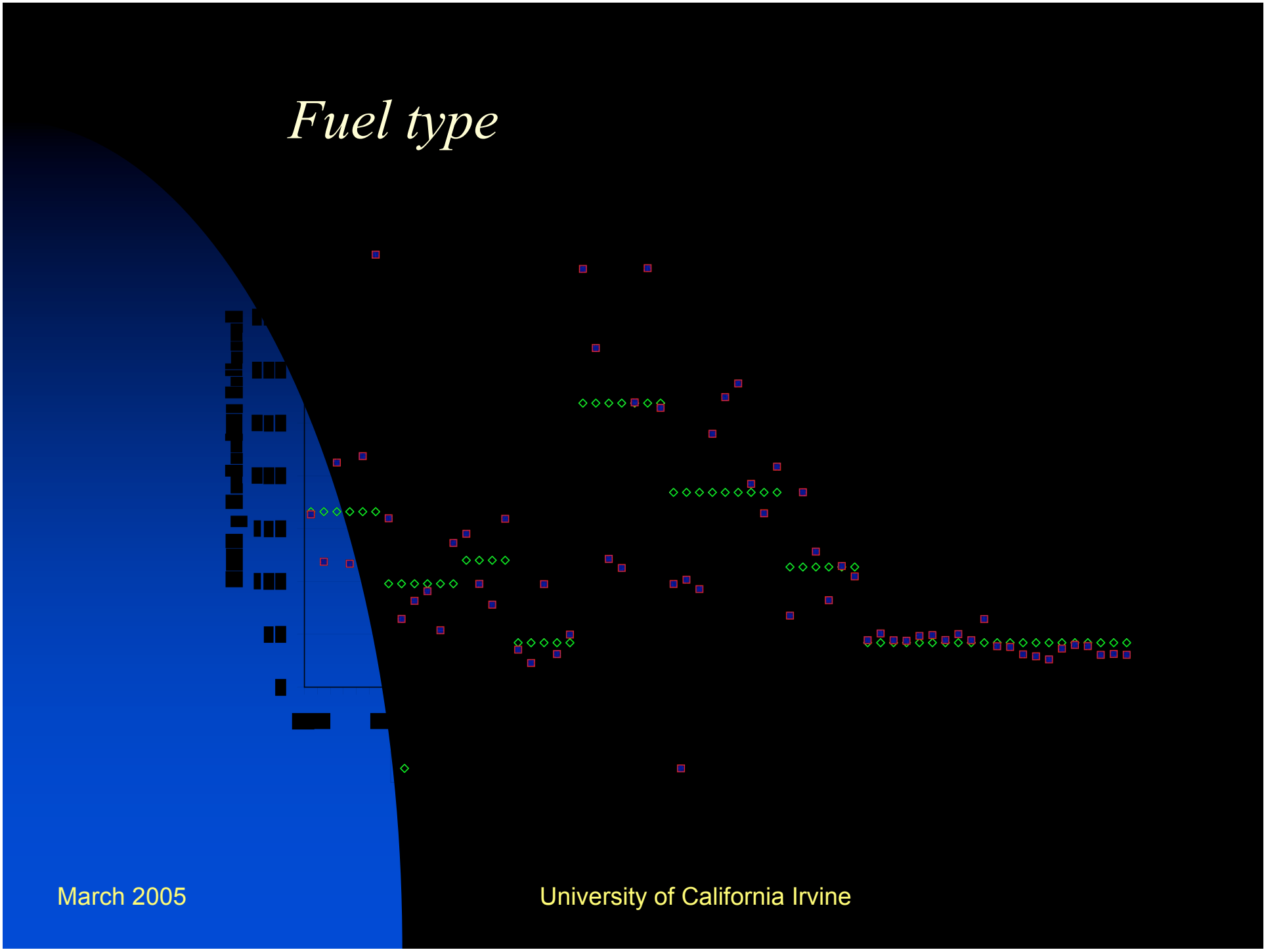
Calculation of global warming commitments

- 20-year GWP
- Molar basis (per carbon atom)
  - CO_2 1.0
  - CH_4 22.6
  - CO 4.5
  - TNMHC 12
- per kg relative to CO_2
  - NO_x 150
- Black carbon?
- Interactions?

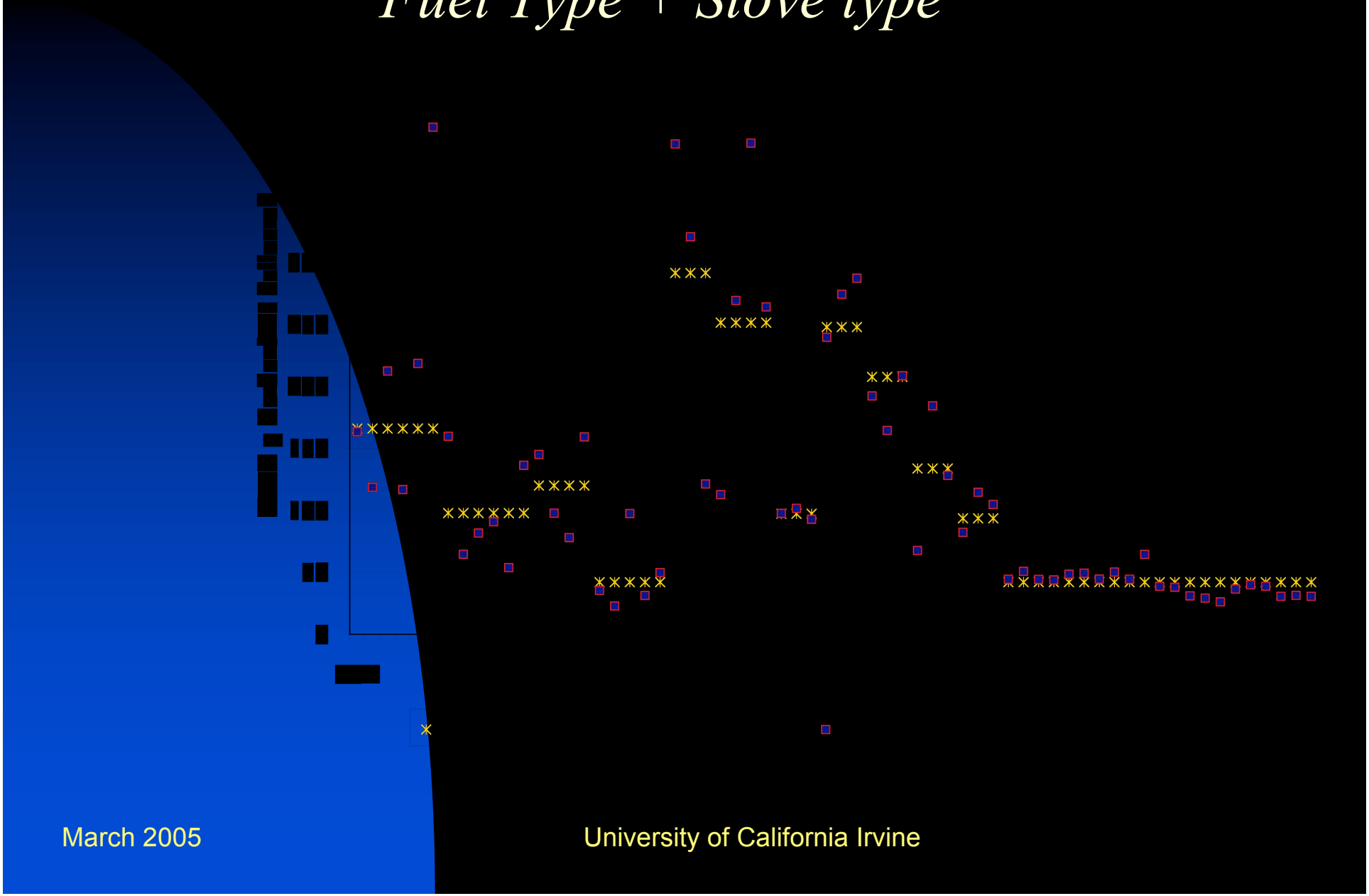
Trading mechanisms- why is the residential sector in the developing world not included?

- Logistical Issues
  - Large numbers of stoves spread over large areas
  - Fuel consumption hard to quantify
  - Involves entering people's homes
- Conceptual issues
  - Individually small emissions
  - Not traditionally seen as an area for engineering innovation
  - Few large commercial enterprises involved
- Currently we use the estimates form the China and India databases, but there are some issues

Fuel type



Fuel Type + Stove type



Fuel type, stove type, CO/CO_2 ratio